THE STUDY
ON
MASTER PLAN ON SUPPLY AND MARKETING SYSTEM OF PETROLEUM PRODUCTS
IN
THE REPUBLIC OF PARAGUAY

— EXECUTIVE SUMMARY —

NOVEMBER 1988

JAPAN INTERNATIONAL COOPERATION AGENCY

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CHAPTER 1 ECONOMY OF PARAGUAY

1.1 General Economy

Paraguay recorded an annual economic growth rate of 8.8% during the 1970s, the highest among all Latin American countries. This high economic growth was largely attributed to the construction of Itaipu Dam, which increased demands in both domestic and neighboring markets. In the early 1980s, when this huge project was almost completed, the Paraguayan economy went into recession. (Table 1).

Paraguay is basically an agricultural country; 45% of the economically active population, about a fourth of GDP, and more than 98% of exports are dominated by agriculture, forestry and livestock industries. In 1987 the manufacturing industry shared 16% of GDP, of which the secondary industries together with mining and construction accounted for 22%. The tertiary industry accounted for 52% of GDP, of which 27% was dominated by commerce. Since about seventy percent of the manufacturing industry is the processing of agricultural products, the industry is easily influenced by agricultural production.

The recent inflation rate of 20% level is lower than those in other Latin American countries.

Table 1 Major Economic Indicators

	1970 – 1980	1980 – 1987	1985	1986	1987
Population (thousand)	2,358 [1]	3,030 [2]	3,681	3,788	n.a.
Pop. growth rate (%)	2.54 [3]	2.99 [4]	2.94	2.90	n.a.
Economic growth rate (%) [5]	8.8	2.2	4.0	0.0	4.3
Price rises					
Consumer price (%)	–	20.4	25.2	31.7	21.8
Wholesale price (%)	16.6	28.2	23.5	45.1	11.9
Growth of exports (%) [5]	10.1	4.9 [4]	37.7	–3.2	30.0
Growth of imports (%) [5]	13.0	5.2 [4]	13.2	5.7	24.9
Trade balance (MM US$)	–6 [6]	–262 [7]	–192	–162	n.a.

1) 1972, census.
2) 1982, census.
3) Annual average of 1972 – 1982.
4) Annual average of 1980 – 1986.
5) Real growth rate.
6) Average value of 1970 – 1980.
7) Average value of 1980 – 1986.

Source: Banco Central del Paraguay, "Cuentas Nacionales 1976/1986."
Secretaria Tecnica de Planificacion, "Plan Nacional de Desarrollo Economico y Social 1985 – 1989."
IMF, "International Financial Statistics."

The central government's financial operations had been deficits in the 1980s but these turned into a surplus after 1986. The Central Bank of Paraguay executes all monetary policies and has all the functions of a Central Bank, such as issuing notes, supervising interest rates and controlling the foreign exchange system. The present foreign exchange system is a multi-tiered system. Under the system, for import of crude oil and petroleum products, the preferential exchange rate of Gs 400 per US$ is applied for FOB price and the free exchange rate for other foreign currency portion.

The balance of payment structure in Paraguay is that in which deficits in trade are balanced by surplus in capital accounts. This trade deficit is due to the international trade structure of exporting agricultural products and importing resources, including petroleum, and all kinds of manufactured goods. Import of crude oil and petroleum products recorded US$97 million in 1986, which accounted for 19% of total import in Paraguay.

1.2 Future Prospects

Population is forecasted to grow at an annual rate of 2.9% from 1987 to 1990, 2.7% from 1990 to 1995, and 2.5% from 1995 to 2000. The results of population forecast are 4.2 million in 1990, 4.8 million in 1995 and 5.5 million in 2000.

As the rapid economic growth in 1970s was mainly due to a specific factor; the construction of Itaipu Dam, such a high growth cannot be expected in the near future. However, the growth rate of 2.2% from 1980 to 1987 was too low, because it was affected by negative growth rates during the recession period from 1982 to 1983. The annual growth rate from 1983 to 1987, excluding the recession period, is 2.8%.

It is envisaged, therefore, that the economy of Paraguay will grow by 3% annually from 1988 to 1995, and 3.5% from 1995 to 2000, with the expectation that the economy of Brazil, which has a great influence on Paraguay, will recover in the late 1990s.

The outlook of the sectoral growth rates are as follows:

	Annual Growth Rate	
	1988 - 1995	1995 - 2000
Primary industry	3.0%	3.0%
Secondary industry	3.0%	3.5%
Tertiary industry	3.0%	3.7%

CHAPTER 2 ENERGY ECONOMY

2.1 Past Trends in Energy Economy

Past records of energy finally consumed in Paraguay (final energy consumption) during the 15 years from 1970 through 1985, are shown in Table 2 in terms of TOE (tons of oil equivalent).

The final energy consumption in Paraguay increased to 2,180,000 TOE from 1,220,000 TOE over the above period at the averaged annual growth rate of 3.9%. However, most of the growth was achieved during the 1970s, and the annual growth rate dropped to 1.9% in the first half of the 1980s due to the stagnant economy.

As shown in the table, energy supply in Paraguay is divided into two groups. One is "commercial" energy which consists of petroleum, coal and electricity, and the other is "non-commercial" energy which includes firewood, charcoal and vegetable residue. One of the characteristics of Paraguay's energy economy is the fact that 75% of the total energy consumed is supplied by non-commercial energy, even in 1985. It is also noted that firewood supplied more than half of the country's total energy consumption. The annual growth rate of each type of energy varies from minus 4.5% for coal to 12.2% for electricity. With the exception of coal within the commercial energy group and that of vegetable residue within the non-commercial energy group, consumption of commercial energy increased at a rate more than twice that of non-commercial energy. As a result, the share held by non-commercial energy decreased during the period.

2.2 Future Energy Prospects in Paraguay

Characteristics of the demand/supply structure of each energy and their future prospects can be summarized as follows:

(1) Petroleum

Consumption of petroleum increased to 458,000 TOE in 1985 from 174,000 TOE in 1970. This was mainly attributed to the expansion of the Transportion sector which shared most of petroleum consumption in Paraguay. On the other hand, the share held by petroleum in energy consumption of the Residential and Commercial sector and Industry sector were relatively small. This is primarily because the retail price of petroleum products in Paraguay are several times more expensive than the prices of firewood, charcoal, and vegetable residue. Accordingly, petroleum products are not so much consumed in the Residential and Commercial sector, and Industry sector, where biomass energy is more cheaply available.

Table 2 Final Energy Consumption in Paraguay by Type of Energy

(Unit: 10^3 TOE)

	Commercial Energy					Non-Commercial Energy				Grand Total
	Petroleum	Coal	Electricity	Fuel Alcohol	Sub Total	Fire Wood	Charcoal	Veg. Residue	Sub Total	
1970	174.0 (14.2%)	0.04 (–)	16.5 (1.4%)	– –	190.5 (15.6%)	921.3 (75.4%)	40.3 (3.3%)	69.5 (5.7%)	1031.2 (84.4%)	1221.7 (100.0%)
1975	226.1 (16.1%)	– –	28.0 (2.0%)	– –	254.1 (18.1%)	984.5 (70.0%)	49.2 (3.5%)	118.7 (8.4%)	1152.4 (81.9%)	1406.5 (100.0%)
1976	254.6 (17.0%)	– –	32.0 (2.1%)	– –	286.7 (19.1%)	1021.3 (68.0%)	51.2 (3.4%)	143.1 (9.5%)	1215.5 (80.9%)	1502.2 (100.0%)
1977	308.4 (19.4%)	0.01 –	39.7 (2.5%)	– –	348.1 (22.0%)	1028.2 (64.8%)	53.1 (3.3%)	157.8 (10.0%)	1239.1 (78.0%)	1587.2 (100.0%)
1978	359.5 (20.6%)	0.03 –	48.7 (2.8%)	– –	408.2 (23.5%)	1098.6 (63.2%)	55.3 (3.2%)	177.0 (10.2%)	1330.9 (76.5%)	1739.0 (100.0%)
1979	396.8 (21.8%)	0.04 –	57.2 (3.2%)	– –	454.0 (25.0%)	1112.3 (61.2%)	57.4 (3.1%)	195.2 (10.7%)	1364.9 (75.0%)	1818.9 (100.0%)
1980	433.5 (21.8%)	0.04 –	66.2 (3.3%)	– –	499.8 (25.2%)	1192.3 (60.1%)	59.7 (3.0%)	233.8 (11.8%)	1485.8 (74.8%)	1985.5 (100.0%)
1981	418.9 (20.9%)	0.03 –	74.6 (3.7%)	4.2 (0.2%)	497.7 (24.8%)	1207.4 (60.3%)	62.0 (3.1%)	237.1 (11.8%)	1506.4 (75.2%)	2004.1 (100.0%)
1982	430.6 (20.8%)	0.03 –	75.8 (3.7%)	8.8 (0.4%)	515.3 (24.9%)	1228.1 (59.3%)	64.4 (3.1%)	263.2 (12.7%)	1555.6 (75.1%)	2070.9 (100.0%)
1983	407.8 (19.2%)	0.02 –	79.5 (3.8%)	8.6 (0.4%)	496.9 (23.4%)	1244.1 (58.7%)	66.7 (3.2%)	312.3 (14.7%)	1623.0 (76.6%)	2118.9 (100.0%)
1984	457.1 (21.2%)	0.04 –	89.8 (4.2%)	12.0 (0.5%)	558.9 (26.0%)	1235.4 (57.4%)	69.2 (3.2%)	289.7 (13.5%)	1594.3 (74.0%)	2153.2 (100.0%)
1985	457.9 (21.0%)	0.02 –	92.8 (4.2%)	9.2 (0.4%)	559.9 (25.7%)	1243.0 (57.0%)	71.6 (3.3%)	307.2 (14.1%)	1621.8 (75.3%)	2181.7 (100.0%)
Annual Compound Rate 1970-1985	6.7%	Δ4.5%	12.2%	–	7.5%	2.0%	3.9%	10.4%	3.1%	3.9%
1970-1980	9.6%	0%	14.9%	–	10.1%	2.6%	4.0%	12.9%	3.7%	5.0%
1980-1985	1.1%	Δ13.0%	7.0%	('81-'85) 21.6%	2.3%	0.8%	3.7%	5.6%	1.7%	1.9%

Source: "Balance Energetico Nacional"

It seems unlikely that this pattern of petroleum consumption will undergo a significant change in the near future. Namely, future consumption of petroleum products will largely depend on the development of the Transportation sector, particularly that of road transportation. In addition, a future increase in the use of LPG within the Residential and Commercial sector will contribute considerably to the future growth of petroleum consumption.

(2) Electricity

Consumption of electricity grew at an annual rate of 12.2%, the highest rate of all energy, during the period from 1970 to 1985. This high growth was realized with background of rapid build-up of electricity generating capacity, mainly by completion of Acaray power stations and Itaipu power station, and expansion of transmission and distribution network by ANDE. As a result, electricity consumption has recorded high growth in each consuming sector with the exception of the Transportation sector. ANDE is planning to proceed with the electrification to cover 75% of the population by the year 2000, from the present coverage of 50%. However, in consideration of the fact that further expansion of the power distribution network will have to cover sparsely populated areas, the rate of increase in electricity users is destined to decline, and therefore, past growth rates of electricity consumption will be difficult to maintain.

(3) Fuel Alcohol

In 1976, the Paraguayan government launched a fuel alcohol (fermentation ethanol) development program using sugar cane as a raw material. The program aimed at improving self-sufficiency in alternative fuel to petroleum and foreign currency savings, etc. Currently, an alcohol plant of APAL (production capacity of 20,000 kℓ/yr) located at Mauricio Jose Troche and a number of private factories in relatively small scale are producing alcohol.

However, a sufficient supply of sugar cane for fuel alcohol production to maintain stable expansion is not assured in future. Accordingly, no remarkable expansion in the supplies of fuel alcohol is expected in the near future.

(4) Firewood

Firewood supplies more than half of the country's total energy consumption, due to its comparatively low price to other energy.

The Residential and Commercial sector consumes three fourths of all firewood mainly as cooking fuel. The position of firewood as the most cheap energy source avail-

able in Paraguay will not change in the near future. However, it is envisaged that the consumption of firewood will not increase significantly from the present level, since the use of firewood in the households will certainly be affected by penetration of LPG and by introduction of kitchen ranges, which will have saving effect on the use of firewood.

(5) Charcoal

The Residential and Commercial sector is the major consuming sector of charcoal presently, in which charcoal is wholly used as cooking fuel.

A key factor that will influence a future demand for charcoal in Paraguay is the extent of requirement of ACEPAR, which started its production of iron and steel in 1987. If ACEPAR's plant is operated at full capacity, the country's charcoal consumption will be more than doubled the level in 1985. However, in this estimation, a more moderate impact by ACEPAR is presupposed.

(6) Vegetable Residue

Consumption of vegetable residue, led by the Industry sector, grew at an annual rate of over 10%. Since processing of agricultural, forestry and livestock products constitute the major manufacturing industries, it is quite natural that the use of vegetable residue as an energy is firmly incorporated in the production system of Paraguayan industry. As long as such agro-industy plays a dominant role in the Industry sector, consumption of vegetable residue as energy will continue to grow in line with the development of the sector.

Based on the future prospects of the macroeconomy of Paraguay described in Chapter 1, and on the above-mentioned prospects, consumption of each energy in the year 2000 is estimated as shown in Table 3.

Table 3 Estimated Energy Consumption in 2000

(Unit: 10^3 TOE)

Energy	Consumption	Annual Compound Rate (1985–2000)
Petroleum	750	3.3%
Electricity	200	5.2%
Fuel Alcohol	12	1.8%
Firewood	1250	0 %
Charcoal	130	4.1%
Vegitable Residue	480	3.0%
Total	2822	1.7%

Source: JICA Mission

CHAPTER 3 PETROLEUM PRODUCTS MARKET

3.1 Demand and Supply of Petroleum Products

The size of petroleum products market in Paraguay in 1987 was about 690 thousand kℓ, if it were defined as PETROPAR's sales amount of all petroleum products except for asphalt.

The demand structure of each petroleum product was as follows: Of all petroleum products, gas oil is in the greatest demand. In 1987, its share on the national consumption was 55.1 %. The second largest demand was for regular gasoline, 15.2 %, and the third was for LPG, 9.1 %. Coming next is premium gasoline (6.4 %), followed by fuel oil (6.1 %), jet fuel oil (5.8 %), kerosene (1.6 %) and aviation gasoline (0.6 %).

As is seen from these figures, the Paraguayan petroleum products market is characterized by its relatively large demand ratio for transportation fuel such as gas oil and gasoline.

As to the regional demand structure, 88 % of the national consumption for total petroleum products is concentrated in Region I "Centro Sur" and Region II "Este". The demand in Region III "Norte" accounts for only about 8 % of the national demand, and that in Region IV "Occidental" a meager 3.5 %.

The concentration of population as well as economic activities in such cities as Asuncion, Pto. Pte. Stoessner and Encarnacion, which are located in Region I and Region II, is considered to be a reason for the concentration of the petroleum demand in Region I and Region II.

Regarding the development of the Paraguayan petroleum market, it has expanded at a relatively high growth rate. Namely, the national petroleum products consumption increased 2.4 times for 12 years from 1975 to 1987, though this market expansion did not occurred uniformly throughout this period.

The demand for petroleum products increased at a high annual average growth rate from 1975 to 1979. For four years from 1979 to 1983, however, the demand did not expand as it did before and even declined in certain years. This stagnant demand was caused by a number of negative factors in the Paraguayan economy, such as the second oil crisis, completion of the construction of the world largest Itaipu hydroelectric dam project, etc. In 1983 and thereafter, the demand for petroleum products recovered to some extent, though its average growth rate has not returned to the level of 1970s.

In Paraguay, the state-owned petroleum corporation, PETROPAR is authorized to supply domestically petroleum products. The functions and activities of PETROPAR are petroleum refining, transportation, storage, sales as well as export and import of crude oil and petroleum products, and exploration and development of hydrocarbon resources in Paraguay. Since petroleum crude oil has not been discovered in Paraguay, she has to rely totally on the imported crude oil.

Crude oil is refined at a 7,500 BPSD refinery located in Villa Elisa. However, as this plant incorporates a simple processing scheme consisting mainly of an atmospheric distillation unit, the operation of the plant is not flexible enough to allow the production of products suited to the demand pattern in Paraguay. Accordingly, gas oil and LPG, which are in great demand, and aviation gasoline and premium gasoline, which are not produced in the said plant, have to be imported by PETROPAR from neighbouring countries.

Actually, of 724 thousand kℓ of petroleum products supply in 1987, the domestically refined products accounted for only about 40 %, and 60 % of the demand had to be imported.

The petroleum products of which rate of domestic production on the total supply in 1987 was over 50 % were regular gasoline (77.8 %), fuel oil (70 %) and kerosene (54.3 %). Meanwhile, the petroleum products of which rate of import on the total supply in 1987 was over 50 % were aviation gasoline (100 %), asphalt (100 %), premium gasoline (93.2 %), LPG (86.0 %), gas oil (68.2 %) and jet fuel (51.2 %).

3.2 Demand Forecast

Table 4 shows the result of demand forecast for petroleum products in Paraguay up to the year 2000.

This demand forecast was made on the basis of the prospects of world petroleum market as well as prospects of Paraguayan economy, energy demand structure and characteristics of the domestic petroleum market. In estimating the future demand, a quantitative analysis was carried out to the greatest possible extent to obtain objective results.

The future annual demand growth rates of various petroleum products from 1988 to the year 2000 are anticipated as follows: jet fuel 4.9 %, LPG 4.4 %, premium gasoline 3.9 %, gas oil 3.7 %, asphalt 3.2 %, regular gasoline 2.4 %, fuel oil 1.6 %, aviation gasoline 0% and kerosene minus 4.7 %.

Table 4 Demand for Petroleum Products and Fuel Alcohol – Past and Future

(Unit: Kℓ)

	Gas Oil	Regular Gasoline 1)	Premium Gasoline	Regular + Premium	Alcohol (Absolute)	Alcohol (95%)	Aviation Gasoline	Kerosene	Jet Fuel	Fuel Oil	LPG	Asphalt 2)	Total Petroleum Products
1975	128,839	61,212	9,134	70,346	0	0	5,247	18,413	8,298	35,896	26,449	n.a.	293,488
1976	149,353	64,069	15,153	79,222	0	0	5,412	19,239	9,060	35,840	28,234	n.a.	326,360
1977	205,611	80,497	21,997	102,494	0	0	6,275	22,451	11,164	39,065	30,138	n.a.	417,198
1978	273,067	95,383	32,498	127,881	0	0	7,329	24,235	12,524	47,836	32,172	n.a.	525,044
1979	265,174	101,300	33,538	134,838	0	0	7,104	20,682	14,076	40,197	34,342	n.a.	516,413
1980	296,269	113,123	28,582	141,705	0	0	6,686	19,782	16,509	30,112	36,659	n.a.	547,722
1981	301,023	98,097	30,161	128,258	5,201	2,588	6,040	15,399	17,959	26,347	39,132	100	534,258
1982	304,941	98,250	27,438	125,688	12,603	4,900	5,734	14,876	15,109	36,456	41,124	45	543,973
1983	307,414	82,807	14,270	97,077	9,204	7,227	4,930	13,948	16,046	30,961	45,274	1,390	517,040
1984	340,726	102,782	20,427	123,209	10,321	12,235	4,385	17,124	19,894	30,925	49,067	3,703	589,033
1985	341,746	102,432	31,601	134,033	3,720	20,540	3,663	22,997	22,669	28,652	54,168	8,427	616,355
1986	349,607	95,824	38,593	134,417	0	13,616	3,875	17,492	33,837	33,543	54,237	10,249	637,257
1987	380,300	105,073	44,371	149,444	2,565	15,500	4,182	10,908	40,239	42,374	62,775	8,119	698,341
1988	377,700	104,000	40,700	144,700	3,400	16,000	4,200	16,700	33,100	35,800	62,000	8,400	682,600
1989	391,000	106,300	42,300	148,600	3,200	16,500	4,200	16,100	35,200	36,300	65,200	8,600	705,200
1990	404,600	108,800	43,800	152,600	3,100	17,100	4,200	15,600	37,400	36,900	68,400	8,900	728,600
1991	418,700	111,200	45,500	156,700	3,000	17,600	4,200	15,000	39,500	37,400	71,700	9,100	752,300
1992	433,200	113,800	47,200	161,000	2,800	18,100	4,200	14,400	41,600	38,000	75,000	9,400	776,800
1993	448,100	116,600	49,000	165,600	2,900	18,500	4,200	13,800	43,700	38,500	78,500	9,700	802,100
1994	463,500	119,500	50,800	170,300	2,900	18,900	4,200	13,200	45,800	39,100	82,000	10,000	828,100
1995	479,300	122,500	52,600	175,100	3,000	19,300	4,200	12,600	48,000	39,700	85,400	10,300	854,600
1996	498,400	126,300	54,800	181,100	3,000	19,700	4,200	12,000	50,100	40,400	88,900	10,600	885,700
1997	518,100	130,200	57,100	187,300	3,000	20,200	4,200	11,400	52,200	41,100	92,500	11,000	917,800
1998	538,400	134,200	59,400	193,600	3,000	20,600	4,200	10,700	54,300	41,800	96,200	11,400	950,600
1999	559,500	138,400	61,800	200,200	3,000	21,100	4,200	10,100	56,500	42,600	100,000	11,800	984,900
2000	581,400	142,700	64,400	207,100	3,000	21,600	4,200	9,400	58,600	43,300	103,900	12,200	1,020,100

Source: PETROPAR
JICA Mission

1) Including absolute alcohol.
2) The density of asphalt is assumed to be 1 Ton/Kℓ in order to convert to Kℓ.

CHAPTER 4 SUPPLY OF PETROLEUM PRODUCTS

4.1 Overview of Petroleum Product Supplies

Paraguay at present depends on its domestic refining and imports for the supplies of petroleum products. In 1987, the domestic refining accounted for about 40% of the supplies and the imports about 60%. PETROPAR, Paraguay's state-run oil company, is the only firm in the country that is responsible for the domestic refining and imports of petroleum products.

Algeria's Saharan Blend, one of the world's ultralight quality crude oils, is used for the refining, because of the country's demand structure of petroleum products and the limits in the existing refining facilities.

Imported petroleum products are purchased from YPF and PETROBRAS, the state-operated oil companies of Argentina and Brazil, respectively, both Paraguay's neighboring countries.

Most of the petroleum products shipped from PETROPAR are distributed to the domestic market by such distributors as Shell, Esso, and COPETROL, and the rest are sold by PETROPAR directly to some specific customers.

4.2 Imports of Petroleum Products

Paraguay imports all the types of petroleum products, ranging from LPG, gasoline, gas oil to asphalt. Gas oil is imported in larger quantities than the other products. Its imports accounted for 62% of all the products imported in 1987, followed by LPG (12%), premium gasoline (9.2%), jet fuel (5.9%), and regular gasoline (4.6%).

Petroleum products imported from YPF and PETROBRAS are transported by barge on the rivers and by tank-truck by land, respectively. Because of the long-distance transportation, the transportation-related costs account for 20 - 30% of the CIF prices of the imported products.

4.3 Imports of Crude Oil and Domestic Refining

Paraguay imports all the crude oil required for its domestic refining and the Saharan Blend is exclusively imported, because a greater part of the domestic demands are for gas oil and gasoline, with a very small demand for heavy fuel oil, and because of the limits in the existing refining facilities.

The crude oil imported from Algeria is transported across the Atlantic Ocean up to the mouth of the Rio de la Plata in an ocean-going tanker of 50,000 - 70,000 tons.

There, a part of the crude oil is transferred to a small tanker of 10,000 - 24,000 tons to allow the ocean-going tanker to draw less water. Then both tankers go up the Parana River, a branch of the Rio de la Plata, to the Zarate Oil Terminal.

At the terminal, the crude oil is unloaded into the tanks there and then loaded into barges of 2,000 - 4,000 kℓ, which go up both the Parana River and the Paraguay River to the Villa Elisa Refinery over a distance of 1,500 km.

The total costs related to the river transportation account for 28% of the CIF price of the imported crude oil, whereas the costs related to the marine transportation make up only 8%. This indicates that Paraguay is at a great disadvantage with respect to transportation costs, because of being an inland country.

Since the Villa Elisa Refinery has no secondary processing units to produce premium gasoline, aviation gasoline and asphalt, these products are all imported. Table 5 shows the supplies of petroleum products by the domestic refining and imports in 1987.

Table 5 Supply of Petroleum Products in 1987

(Unit: 10^3 Kℓ)

	Production				Import				Supply total	
	Gross production	Internal consumption	Net production	%	VE from Petrobras	VE from YPF	HE from Petrobras	Import total	%		
Gas Oil	130.27	0.29	129.98	(31.8)	5.57	200.49	72.40	278.46	(68.2)	408.44	(100.0)
Regular Gasoline	84.81		81.81	(79.8)	–	5.37	15.29	20.66	(20.2)	102.47	(100.0)
Premium Gasoline	–		3.0	(6.8)	11.53	29.64	–	41.17	(93.2)	44.17	(100.0)
Aviation Gasoline	–		–		4.24	–	–	4.24	(100.0)	4.24	(100.0)
Jet Fuel	25.42		25.42	(48.8)	11.73	14.93	–	26.66	(51.2)	52.08	(100.0)
Kerosene	3.98		3.98	(54.3)	–	3.35	–	3.35	(45.7)	7.33	(100.0)
Fuel Oil	36.86	6.74	30.12	(70.0)	–	12.88	–	12.88	(30.0)	43.00	(100.0)
LPG	8.85	0.08	8.87	(14.1)	54.05	–	–	54.05	(86.0)	62.82	(100.0)
(Asphalt Ton)					(1,106)	(6,793)	–	(7,899)	(100.0)	(7,899)	(100.0)
Total	290.19	7.11	283.08	(39.1)	87.12	266.66	87.69	441.47	(60.9)	724.55	(100.0)

Note: VE: Villa Elisa
HE: Hernandarias

Source: PETROPAR
JICA Mission

4.4 Domestic Distribution of Petroleum Products

Petroleum products are shipped to the domestic market from both the Villa Elisa Refinery and the Hernandarias Depot of PETROPAR. The latter supplies only regular gasoline and gas oil to the markets mainly in the eastern part of the country. Of all the shipments of petroleum products in 1987, 86% was from the refinery and 14% from the depot.

The routes for the product distribution are basically divided into two: One is from PETROPAR to end-users via distributors and retailors (service stations). The other is from PETROPAR directly to its customers.

A greater part of the products are sold through distributors. PETROPAR directly sells only to such specific customers as government organizations, state-run companies, and co-operatives.

The three leading distributors of Shell, Esso, and COPETROL account for 85% of the total sales of products.

Maximum retail prices of petroleum products in Paraguay are regulated by a government decree. And another decree stipulates the rates of taxes levied on the petroleum products. PETROPAR, in accordance to the decrees, decides the distributors' and retailers' allowances, and, consequently, ex-PETROPAR prices of petroleum products.

In the past years, there were such cases in which prices of petroleum products were revised several times a year. However, the prices enacted on January 7, 1987 lasted until January 20, 1988, when they were revised with an about 15% rise for each product (see Table 6).

CHAPTER 5 EXISTING FACILITIES

5.1 Villa Elisa Refinery

PETROPAR's refinery is located at Villa Elisa, Central Department, in the suburbs about 12 km southeast of the center of Asuncion, the capital of Paraguay. This refinery was constructed for REPSA, the predecessor of PETROPAR, and came into operation in 1966.

The Villa Elisa Refinery has so far been operating as the sole refinery in Paraguay, regardless of the reorganization of REPSA into PETROPAR and the subsequent nationalization of PETROPAR.

The refinery, constructed about 20 years ago, seems to have been provided with adequate maintenance.

PETROPAR owns not only the Villa Elisa Refinery but also the Calera Cue Product Storage Terminal which is located about 15 km upstream of the Paraguay River from the

Table 6 Retail Price Structure of Petroleum Products in Paraguay for 1987 and 1988

(Unit: Gs/ℓ)

Petroleum Product	Year	Retail Price	Breakdown of Retail Price											
			MOPC Fund		Domestic Tax		Distributor Allowance		Retailor Allowance		Freight Fund		Ex-PETROPAR Price	
1. Household LPG (Gs/Kg)	1987	240.00	–	–	24.00	10.0%	47.00	19.6%	11.00	4.6%	–	–	158.00	65.8%
	1988	240.00	–	–	24.00	10.0%	47.00	19.6%	11.00	4.6%	–	–	158.00	65.8%
2. Automobile LPG (Gs/Kg)	1987	–	–	–	–	–	–	–	–	–	–	–	–	–
	1988	300.00	–	–	30.00	10.0%	47.00	15.7%	–	–	–	–	223.00	74.3%
3. Regular Gasoline	1987	285.00	–	–	118.28	41.5%	14.77	5.2%	18.87	6.6%	–	–	133.08	46.7%
	1988	330.00	–	–	136.95	41.5%	15.50	4.7%	21.70	6.6%	0.92	0.3%	154.93	46.9%
4. Premium Gasoline	1987	320.00	–	–	126.59	39.6%	14.00	4.4%	19.83	6.2%	–	–	159.58	49.9%
	1988	370.00	–	–	146.37	39.6%	15.04	4.1%	22.80	6.2%	0.92	0.2%	184.87	50.0%
5. Aviation Gasoline	1987	360.00	–	–	72.00	20.0%	14.52	4.0%	–	–	–	–	273.48	76.0%
	1888	400.00	–	–	80.00	20.0%	17.00	4.3%	–	–	0.92	0.2%	302.08	75.5%
6. Kerosene	1987	200.00	–	–	20.00	10.0%	8.27	4.1%	9.45	4.7%	–	–	162.28	81.1%
	1988	230.00	–	–	23.00	10.0%	8.45	3.7%	10.87	4.7%	0.92	0.4%	186.76	81.2%
7. Jet Fuel	1987	200.00	–	–	20.00	10.0%	9.90	5.0%	–	–	–	–	170.10	85.1%
	1988	230.00	–	–	23.00	10.0%	11.22	4.9%	–	–	0.92	0.4%	194.86	84.7%
8. Gas Oil	1987	165.00	3.00	1.8%	17.44	10.6%	8.68	5.3%	11.00	6.7%	–	–	124.88	75.7%
	1988	190.00	4.00	2.1%	20.08	10.6%	8.92	4.7%	12.65	6.7%	0.92	0.5%	143.43	75.5%
9. Fuel Oil	1987	105.00	–	–	10.50	10.0%	6.80	6.5%	–	–	–	–	87.70	83.5%
	1988	120.00	–	–	12.00	10.0%	6.50	5.4%	–	–	0.92	0.8%	100.58	83.8%
10. Cement Asphalt (Gs/Kg)	1987	116.74												
	1988	116.74												

Source: PETROPAR

refinery. This terminal is provided with product tanks to store gas oil and fuel oil imported as well as produced by the refinery, and also with a facility to ship the stored products by barges.

A process flow scheme of the Villa Elisa Refinery is shown in Fig. 1. The Saharan Blend crude oil, which is one of the world's lightest crude oils, is processed at the refinery since no secondary processing unit is provided in the refinery and there is a small domestic demand for fuel oil.

Petroleum products produced at the refinery are LPG, regular gasoline, kerosene, jet fuel, gas oil and fuel oil. Premium gasoline, aviation gasoline and asphalt are not produced at the refinery because no production unit for these products is provided in the refinery.

5.2 Zarate Oil Terminal

The Zarate Oil terminal is located at Zarate along the Parana River, about 100 km north-west of Buenos Aires, east of Argentina and serves principally as a transshipment terminal for imported crude oil.

The terminal is furnished with two jetties and three crude oil tanks. One of the jetties is for tankers with a maximum capacity of 50,000 tons, and the other is for barges.

5.3 Hernandarias Depot

The Hernandarias Depot is located about 10 km north of Stroessner City, Alto Parana Department, in Eastern Paraguay. The depot receives regular gasoline and gas oil imported from PETROBRAS and delivers them mainly to the markets in the eastern part of the country. The main facilities of the depot are tanks and receiving/shipping facilities for these products.

CHAPTER 6 PLANNING OF FUTURE SUPPLY SYSTEM FOR PETROLEUM PRODUCTS

6.1 Outline of Alternative Supply Plans

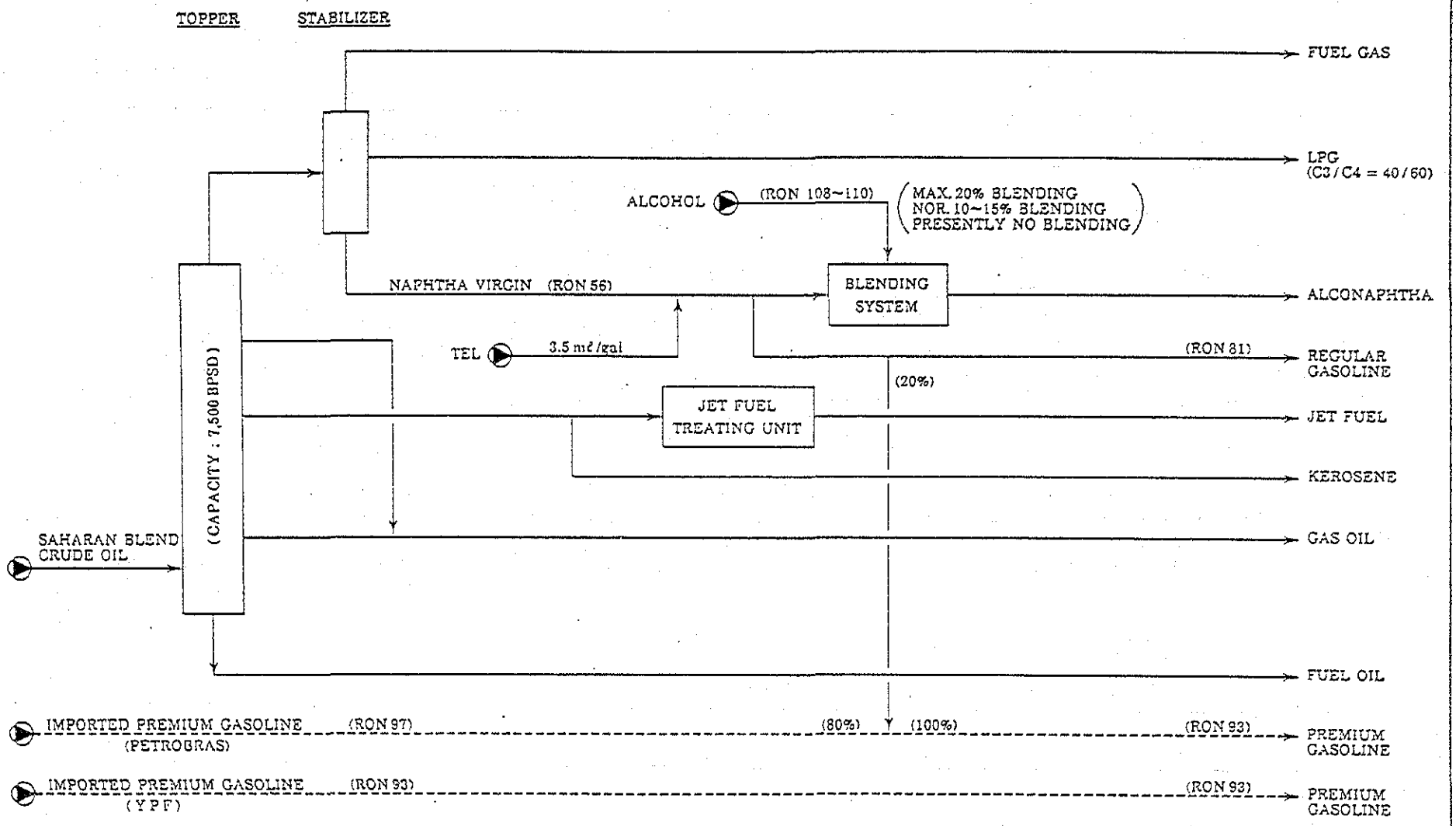
The following three cases are planned for the future supplies of petroleum products, according to the difference in dependence on domestic refining and product imports.

The outline of the supply system in respective cases is summarized in Table 7.

(1) Case-1

All the petroleum products will be imported to satisfy the demands in Paraguay up to the year 2000.

In the Villa Elisa Refinery, the existing crude distillation unit will be shut down, and



Source : PETROPAR

Fig. 1 Process Flow Scheme for Existing Refinery

Table 7 Outline of Supply System

Item	Case-1	Case-2	Case-3
1. Crude Oil	–	Bonny Light (Nigeria)	Saharan Blend (Algeria)
2. Transportation of Crude Oil	–	By the present transportation route and method.	——→
3. Existing Refinery	The existing crude distillation unit will be shut down and the refinery will be used as a terminal for product import.	A new crude distillation unit and some secondary processing units will be installed.	The existing crude distillation unit will be revamped and new process units will be installed for production of premiun gasoline.
4. Supplier of Import Products	YPF and PETROBRAS	——→	——→
5. Transportation of Import Products	From YPF: Fluvial Transportation by barge From PETROBRAS: Land-based Transportation by tank-truck	——→	——→
6. Domestic Distribution	By distributors (Shell, Esso, COPETROL, etc.) or directly by PETROPAR.	——→	——→
7. Depot	The existing Hernandarias Depot will be expanded to cover the petroleum products demands in Region II.	——→	——→

Source: JICA Mission

the storage, receiving and shipping facilities will be expanded to meet the requirements in the year 2000. The refinery will be used as a terminal for imports and domestic distribution of petroleum products. However, the crude distillation unit will be kept in good maintenance to prepare for its future reuse.

The petroleum products required will be imported from YPF of Argentina and PETROBRAS of Brazil. Products from YPF will be transported by barge and those from PETROBRAS by tank-truck.

The existing petroleum product depot at Hernandarias will be expanded to meet the demand for petroleum products in Region II (Este) in the year 2000. However, products to be handled at this depot will be limited to those products of regular and premium gasolines and gas oil for which relatively large demands are expected.

Methods and means of distribution of imported products from both the Villa Elisa Oil Terminal and the Hernandarias Depot will be the same as at present.

(2) Case-2

The majority of the domestic demands for petroleum products up to the year 2000 will be covered by the products from the refinery and the rest by imports. Consequently, the ratio of products supplied by the domestic refining and the imports will be approximately 93% / 7%.

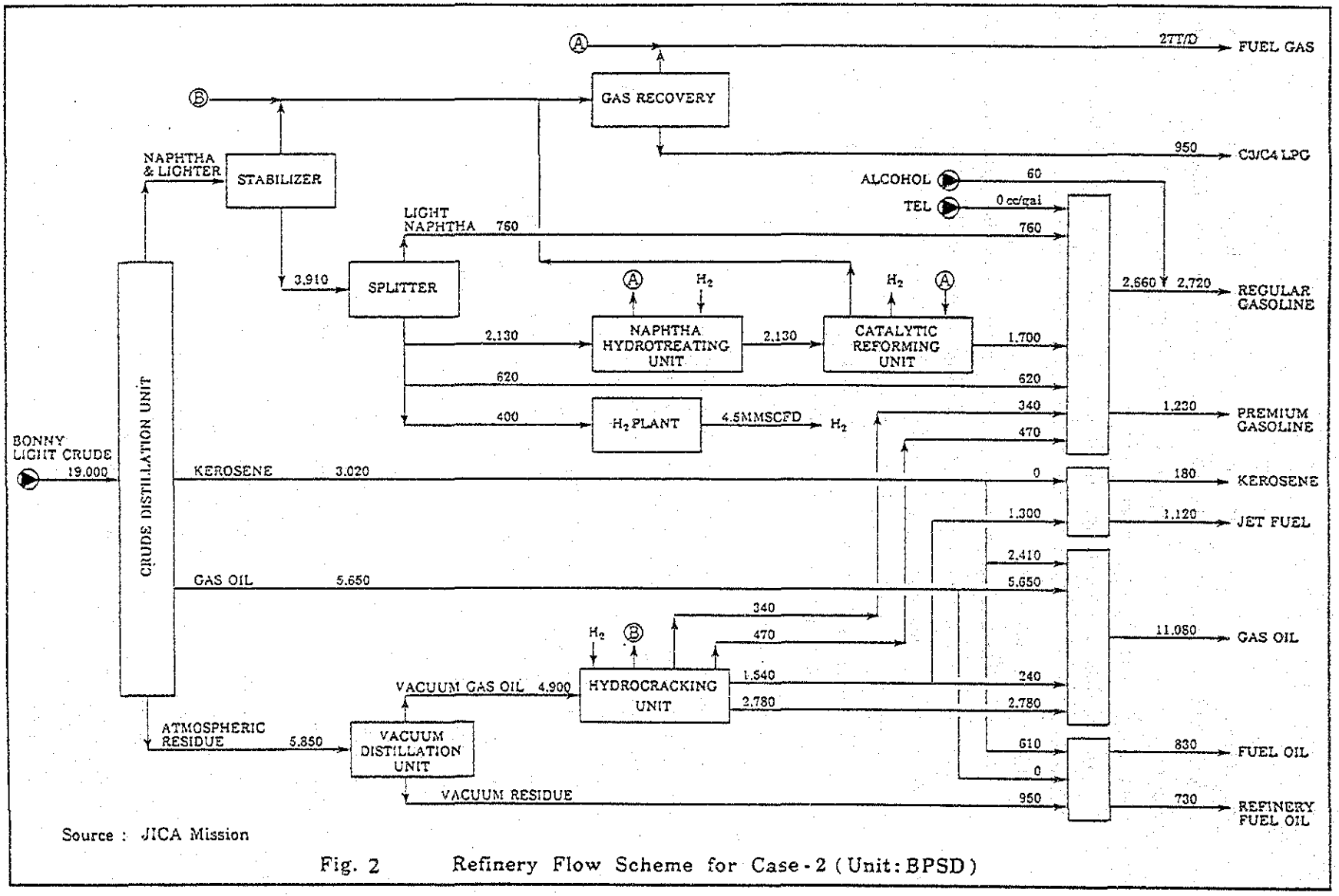
A study has been made to select the most suitable crude oil to be processed in the refinery out of a number of crudes that are supposed to be available to Paraguay. The Bonny Light crude is selected from the viewpoints of its stable supplies, properties, and acquisition cost, etc. The method and means of transportation of imported crude oil will be the same as at present.

A crude distillation unit with a capacity of 19,000 BPSD and various secondary processing units will be newly installed in the refinery to permit the maximum petroleum product supplies by domestic refining, within the extent of causing no excess production in any of the intended products.

The existing crude distillation unit will be shutdown but will be kept in good maintenance to prepare for its possible reuse in the future.

Aviation gasoline and asphalt will not be produced at the new refinery. Accordingly, whole demand for these products will be supplied by imports. The flow scheme of the refinery for Case-2 is shown in Fig. 2.

The suppliers and means of transportation of imported products, expansion and use of the depot, and domestic distribution of products will be the same as in Case-1.



Source : JICA Mission

Fig. 2 Refinery Flow Scheme for Case-2 (Unit: BPSD)

(3) Case-3

The demand for petroleum products up to the year 2000 will be satisfied by both domestic refining and product imports. The ratio in the year 2000 of domestically refined to imported products will be approximately 42% / 58%.

The crude oil to be refined in the refinery will be the Saharan Blend crude oil which has been used so far. Transportation of the imported crude will also be the same as at present.

The existing crude distillation unit in the refinery will be revamped to increase its capacity to 10,000 BPSD. However, its actual crude oil throughput in the year 2000 will have to be limited to approximately 8,400 BPSD to avoid an overproduction of the products.

In addition, some secondary processing units will be newly installed to produce premium gasoline which has not been produced in the existing refinery and wholly imported so far. The process flow scheme for Case-3 is shown in Fig. 3.

The suppliers and means of transportation of imported products, expansion and use of the depot, and domestic distribution of products will be the same as in Case-1.

6.2 Petroleum Product Supply Balance

(1) Supply Balance in Case-1

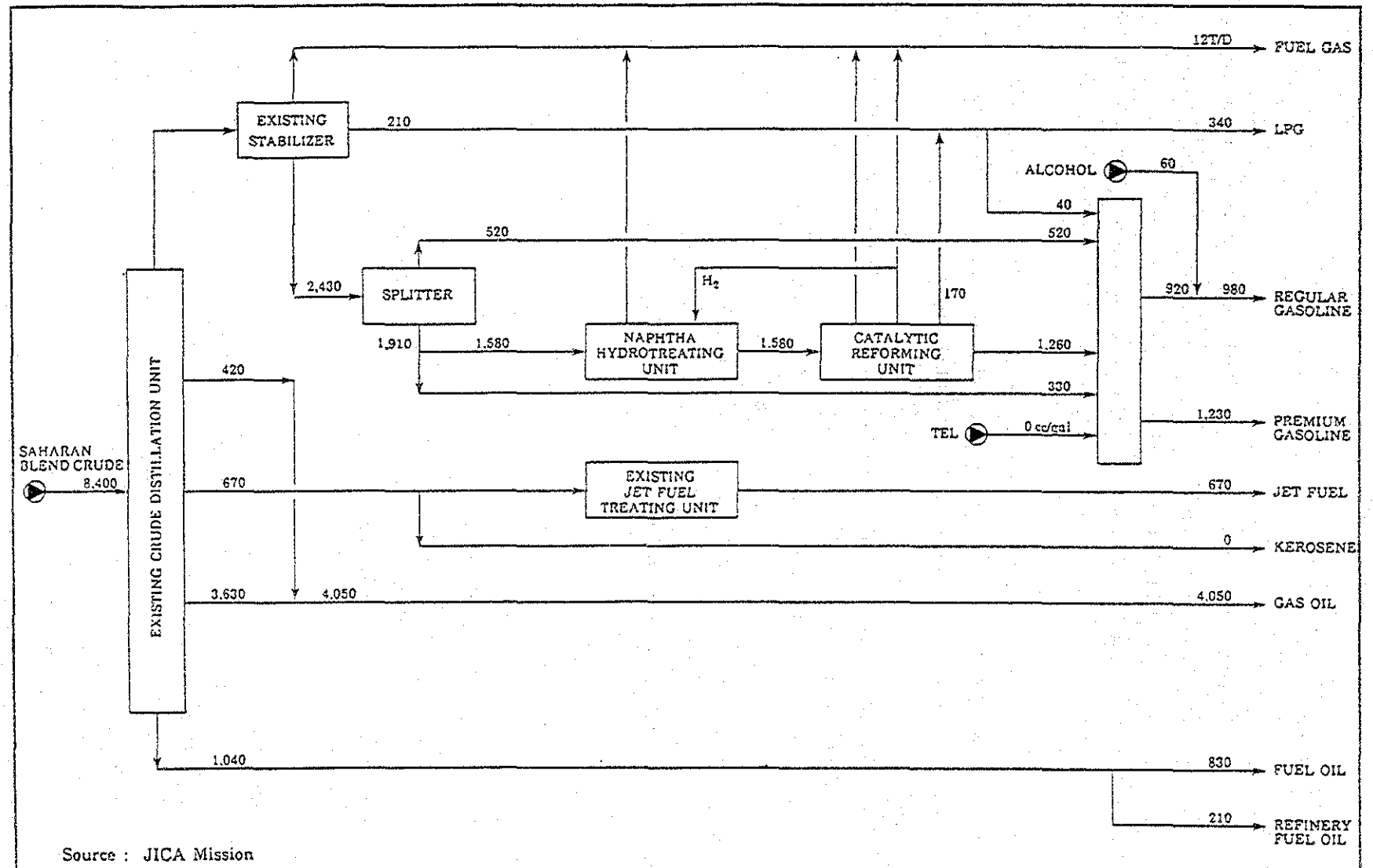
Fig. 4 shows the supply balance of the petroleum products for Case-1 in the year 2000. The total demand for petroleum products in the year 2000 will be 1,020,100 kℓ, all of which will be imported, except 3,000 kℓ of anhydrated alcohol produced in Paraguay and blended with regular gasoline.

The products to be imported from YPF of Argentina will amount to 662,200 kℓ and the imports from PETROBRAS of Brazil will amount to 354,900 kℓ, thus the ratio being 65% / 35%.

(2) Supply Balance in Case-2

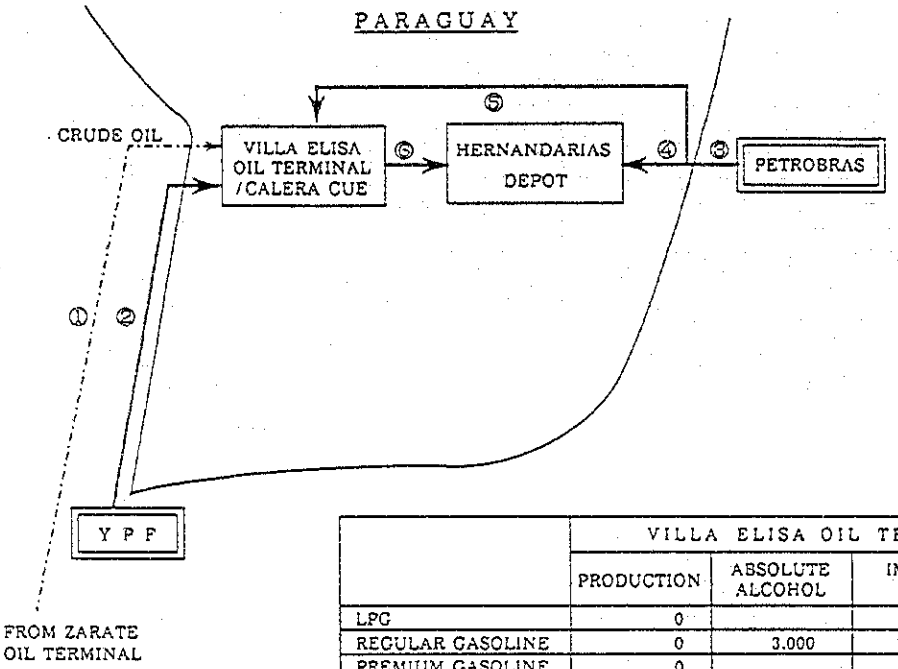
The supply balance of petroleum products in the year 2000 for Case-2 is shown in Fig. 5. Of the total demand for petroleum products of 1,020,100 kℓ in the year 2000, 949,600 kℓ is to be supplied by the refinery and by anhydrated alcohol, and the remaining 70,500 kℓ will be imported. The ratio of the domestic refining (including anhydrated alcohol) to the imports will be 93% / 7%.

The crude oil to be used at the refinery is to be the Bonny Light crude, and the amount to be imported and refined in the year 2000 will be 996,800 kℓ.



Source : JICA Mission

Fig. 3 Refinery Flow Scheme for Case-3 (Unit: BPSD)



DEMAND & SUPPLY BALANCE

(Unit : Kℓ/Y)

	DEMAND	SUPPLY		
		DOMESTIC REFINING	PRODUCT IMPORT ② + ③	ABSOLUTE ALCOHOL
LPG	103,900	0	103,900	
REGULAR GASOLINE	142,700	0	139,700	3,000
PREMIUM GASOLINE	64,400	0	64,400	
AVIATION GASOLINE	4,200	0	4,200	
KEROSENE	9,400	0	9,400	
JET FUEL	58,600	0	58,600	
GAS OIL	581,400	0	581,400	
FUEL OIL	43,300	0	43,300	
ASPHALT	12,200	0	12,200	
TOTAL	1,020,100	0	1,017,100	3,000
CRUDE OIL ①				

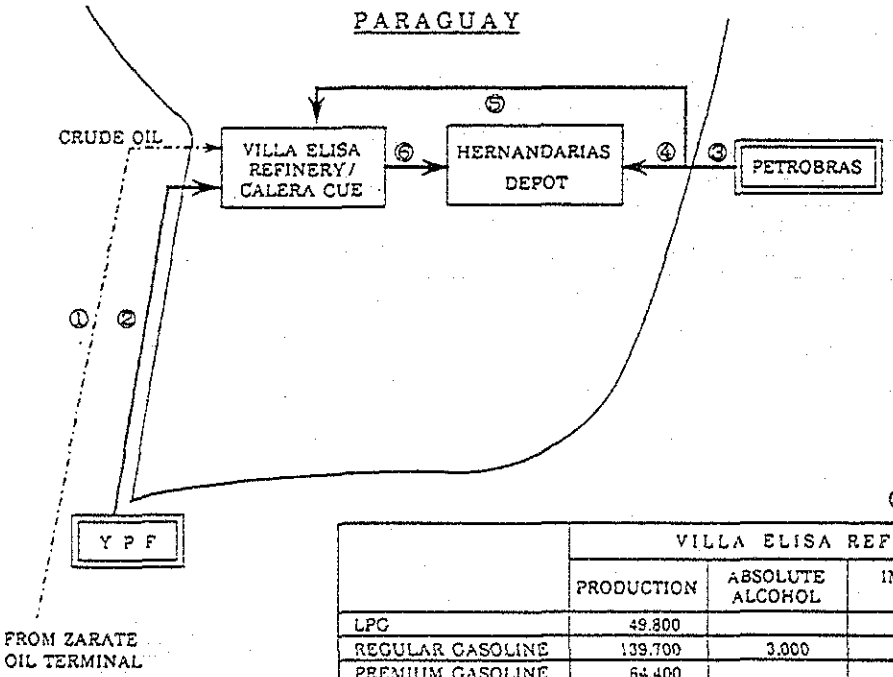
OIL HANDLING

(Unit : Kℓ/Y)

	VILLA ELISA OIL TERMINAL / CALERA CUE					HERNANDARIAS DEPOT		
	PRODUCTION	ABSOLUTE ALCOHOL	IMPORT ②	IMPORT ⑤	TOTAL	IMPORT ④	TRANSFER ⑥	TOTAL
LPG	0		0	103,900	103,900	0	0	0
REGULAR GASOLINE	0	3,000	92,700	0	95,700	47,000	0	47,000
PREMIUM GASOLINE	0		52,200	0	52,200	12,200	0	12,200
AVIATION GASOLINE	0		0	4,200	4,200	0	0	0
KEROSENE	0		9,400	0	9,400	0	0	0
JET FUEL	0		58,600	0	58,600	0	0	0
GAS OIL	0		393,800	0	393,800	187,600	0	187,600
FUEL OIL	0		43,300	0	43,300	0	0	0
ASPHALT	0		12,200	0	12,200	0	0	0
TOTAL	0	3,000	662,200	108,100	773,300	246,800	0	246,800
CRUDE OIL ①								

Source : JICA Mission

Fig. 4 Petroleum Supply Balance in 2000 for Case-1



DEMAND & SUPPLY BALANCE

(Unit : Kℓ/Y)

	DEMAND	SUPPLY		
		DOMESTIC REFINING	PRODUCT IMPORT ② + ③	ABSOLUTE ALCOHOL
LPG	103,900	49,800	54,100	
REGULAR GASOLINE	142,700	139,700	0	3,000
PREMIUM GASOLINE	64,400	64,400	0	
AVIATION GASOLINE	4,200	0	4,200	
KEROSENE	9,400	9,400	0	
JET FUEL	58,600	58,600	0	
GAS OIL	581,400	581,400	0	
FUEL OIL	43,300	43,300	0	
ASPHALT	12,200	0	12,200	
TOTAL	1,020,100	946,600	70,500	3,000
CRUDE OIL ①		996,800		

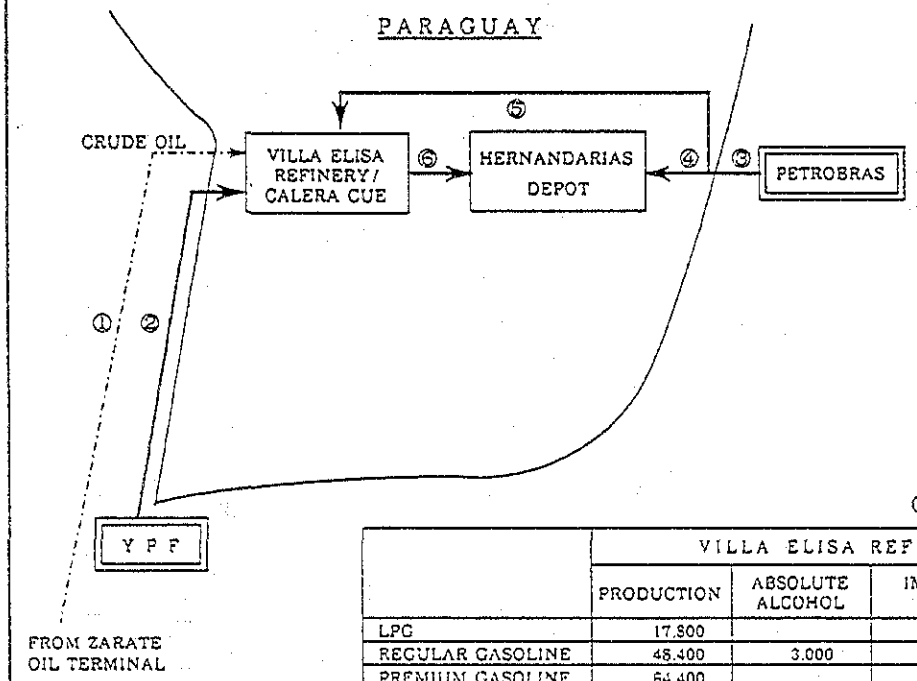
OIL HANDLING

(Unit : Kℓ/Y)

	VILLA ELISA REFINERY / CALERA CUE					HERNANDARIAS DEPOT		
	PRODUCTION	ABSOLUTE ALCOHOL	IMPORT ②	IMPORT ⑤	TOTAL	IMPORT ④	TRANSFER ⑥	TOTAL
LPG	49,800		0	54,100	103,900	0	0	0
REGULAR GASOLINE	139,700	3,000	0	0	142,700	0	47,000	47,000
PREMIUM GASOLINE	64,400		0	0	64,400	0	12,200	12,200
AVIATION GASOLINE	0		0	4,200	4,200	0	0	0
KEROSENE	9,400		0	0	9,400	0	0	0
JET FUEL	58,600		0	0	58,600	0	0	0
GAS OIL	581,400		0	0	581,400	0	187,600	187,600
FUEL OIL	43,300		0	0	43,300	0	0	0
ASPHALT	0		12,200	0	12,200	0	0	0
TOTAL	946,600	3,000	12,200	58,300	1,020,100	0	246,800	246,800
CRUDE OIL ①	996,800							

Source : JICA Mission

Fig. 5 Petroleum Supply Balance in 2000 for Case-2



DEMAND & SUPPLY BALANCE

(Unit : Kℓ/Y)

	DEMAND	SUPPLY		
		DOMESTIC REFINING	PRODUCT IMPORT ② + ③	ABSOLUTE ALCOHOL
LPG	103.900	17.800	86.100	
REGULAR GASOLINE	142.700	48.400	91.300	3.000
PREMIUM GASOLINE	64.400	64.400	0	
AVIATION GASOLINE	4.200	0	4.200	
KEROSENE	9.400	0	9.400	
JET FUEL	58.600	35.200	23.400	
GAS OIL	581.400	212.500	368.900	
FUEL OIL	43.300	43.300	0	
ASPHALT	12.200	0	12.200	
TOTAL	1.020.100	421.600	595.500	3.000
CRUDE OIL ①		440.700		

OIL HANDLING

(Unit : Kℓ/Y)

	VILLA ELISA REFINERY / CALERA CUE					HERNANDARIAS DEPOT		
	PRODUCTION	ABSOLUTE ALCOHOL	IMPORT ②	IMPORT ⑤	TOTAL	IMPORT ④	TRANSFER ⑥	TOTAL
LPG	17.800		0	86.100	103.900	0	0	0
REGULAR GASOLINE	48.400	3.000	44.300	0	95.700	47.000	0	47.000
PREMIUM GASOLINE	64.400		0	0	64.400	0	12.200	12.200
AVIATION GASOLINE	0		0	4.200	4.200	0	0	0
KEROSENE	0		9.400	0	9.400	0	0	0
JET FUEL	35.200		23.400	0	58.600	0	0	0
GAS OIL	212.500		181.300	0	393.800	187.600	0	187.600
FUEL OIL	43.300		0	0	43.300	0	0	0
ASPHALT	0		12.200	0	12.200	0	0	0
TOTAL	421.600	3.000	270.600	90.300	785.500	234.600	12.200	246.800
CRUDE OIL ①	440.700							

Source : JICA Mission

Fig. 6 Petroleum Supply Balance in 2000 for Case-3

Imports of refined products from YPF and PETROBRAS will be 12,200 kℓ and 58,300 kℓ, respectively, the ratio hence being 17% / 83%.

(3) Supply Balance in Case-3

The supply balance of petroleum products in the year 2000 for Case-3 is shown in Fig. 6. Of the total product demand of 1,020,100 kℓ in the year 2000, 424,600 kℓ will be supplied domestically, and the balance of 595,500 kℓ will be imported. The ratio of the domestic refining (including anhydrated alcohol) to the imports will be 42% / 58%.

Crude oil processed at the refinery is to be the Saharan Blend crude and the annual imports in the year 2000 will amount to 440,700 kℓ.

The product imports from YPF and PETROBRAS will be 270,600 kℓ and 324,900 kℓ, respectively, thus the ratio being 45% / 55%.

CHAPTER 7 DESCRIPTION OF SUPPLY FACILITIES

The supply facilities in respective cases have been planned according to demand for the petroleum products in the year 2000.

7.1 Supply Facilities for Case-1

(1) Villa Elisa Oil Terminal

(i) Process Units

The existing crude distillation and jet fuel treating units will be shut down.

(ii) Utility Facilities

The utilities required at the oil terminal will be supplied from the existing utility facilities. Electricity and boiler fuel oil will be supplied from outside the terminal.

(iii) Storage Facilities

The number of tanks, newly installed in the Villa Elisa Oil Terminal, is summarized in Table 8.

(iv) Wharfs

The existing two wharfs will be used, as they are.

(v) Land Shipping Facilities

The capacity of the existing facilities for gas oil and LPG will be increased, whereas the facilities for the other products will be used, as they stand.

Table 8 Tank List for Case-1

Crude/Product	Existing Tanks		Total Requirement (Kℓ)	Additional Requirement (Kℓ)	New Tanks	
	Item No. (D9-)	Capacity (Kℓ)			Capacity (Kℓ)	Type
(1) LPG	916, 919, 920, 924, 925	300	7,000	6,700	2,000 x3 1,000 x1	SPH SPH
(2) Regular Gasoline	907, 921, 922, 917	36,300	35,200	–	–	
(3) Premium Gasoline	904, 905, 908, 915, 902	20,565	16,600	–	–	
(4) Aviation Gasoline	903, 918	1,380	1,200	–	–	
(5) Kerosene	909, 913	3,050	2,600	–	–	
(6) Jet Fuel	906, 910	2,780	16,000	13,200	13,000 x1	CR
(7) Gas Oil	923, 926, 927 928, 929, ES-2 901	99,200	143,800	44,600	25,000 x2	CR
(8) Fuel Oil	911, 912, ES-1	15,760	11,900	–	–	
(9) Asphalt	935, 936, 937	1,230	3,400	2,170	2,000 x1	CRH
(10) Alcohol	914	1,680	800	–	–	

Source: JICA Mission
Note SHP: Spherical Tank
CR: Cone Roof Tank
CRH: Cone Roof Tank with heating

Table 9 Capacity of Process Unit for Case-2

Process Unit	Capacity (BPSD)
1. Crude Distillation Unit	19,000
2. Vacuum Distillation Unit	5,900
3. Naphtha Hydrotreating Unit	2,200
4. Catalytic Reforming Unit	2,200
5. Hydrocracking Unit	4,900
6. Hydrogen Plant	4.5 MMSCFD
7. Gas Recovery Unit	1,100
8. Sour Water Stripper	10 Ton/hr

Source: JICA Mission

(2) Hernandarias Depot

The capacity of the existing storage tanks and receiving/shipping facilities will be increased for regular gasoline and gas oil. A tank and a receiving/shipping facility will be newly installed for premium gasoline.

7.2 Supply Facilities for Case-2

(1) Villa Elisa Refinery

(i) Process Units

The existing crude distillation and jet fuel treating units will be shut down and a new 19,000 BPSD crude distillation unit will be installed. As secondary processing units, a vacuum distillation unit and a vacuum gas oil hydrocracking unit will be newly introduced to reduce the yield of fuel oil and to enhance the yield of gas oil. A catalytic reforming unit to produce premium gasoline will also be installed.

The new process units are listed in Table 9.

(ii) Utility Facilities

- Two package boilers each having a capacity of 10 t/h will be newly installed, whereby the operation of the existing two boilers will be stopped.
- Additional power receiving facilities with a capacity of 2,600 kW will be installed to receive the required electricity supplied from outside the refinery.
- Cooling water and make-up water will be supplied from the existing water supply facilities.

(iii) Storage Facilities

The number of tanks, newly installed in the Villa Elisa Refinery, is summarized in Table 10.

(iv) Wharfs

The existing two wharfs will be used, as they are.

(v) Land Shipping Facilities

The capacity of the existing facilities for gas oil and LPG will be increased, while the facilities for the other products will be used, as they stand.

(2) Zarate Oil Terminal

The existing terminal will be used, as it is, for the transshipment of the crude oil imported from Nigeria.

(3) Hernandarias Depot

As in Case-1, some reinforcements and a new facility will be added to the existing depot.

Table 10 Tank List for Case-2

Crude/Product	Existing Tanks		Total Requirement (Kℓ)	Additional Requirement (Kℓ)	New Tanks	
	Item No. (D9-)	Capacity (Kℓ)			Capacity (Kℓ)	Type
1. Crude Tank	901, 902, 917	62,900	167,700	104,800	50,000 x2	FR
2. Product Tank						
(1) LPG	916, 919, 920, 924, 925	300	7,000	6,700	2,000 x3 1,000 x1	SPH SPH
(2) Regular Gasoline	907, 922	8,900	8,700	–	–	
(3) Premium Gasoline	904, 905	2,750	3,000	–	–	
(4) Aviation Gasoline	903, 918	1,380	1,200	–	–	
(5) Kerosene	913	1,400	1,000	–	–	
(6) Jet Fuel	906, 909, 910	4,430	6,400	1,970	2,000 x1	CR
(7) Gas Oil	928, 929, ES-2	40,400	35,600	–	–	
(8) Fuel Oil	912, ES-1	1,680 12,400	3,700	2,020	2,000 x1	CRH
(9) Asphalt	935, 936, 937	1,230	3,400	2,170	2,000 x1	CRH
(10) Alcohol	914	1,680	800	–	–	
3. Intermediate Tank						
(1) SR Light Naphtha	915	815	800	–	–	
(2) SR Heavy Naphtha	921	2,400	2,400	–	–	
(3) Reformate	908	2,500	1,900	–	–	
(4) HCR Light Naphtha	–	–	400	400	1,000 x1	FR
(5) HCR Heavy Naphtha	–	–	500	500	1,000 x1	FR
(6) SR Kerosene	923	6,400	3,400	–	–	
(7) SR Gas Oil	926	14,500	6,300	–	–	
(8) HCR Gas Oil	927	14,500	3,100	–	–	
(9) Vacuum Residue	911	1,680	1,100	–	–	

Source: JICA Mission
Note SPH: Spherical Tank
CR: Cone Roof Tank
CRH: Cone Roof Tank with heating
FR: Floating Roof Tank

7.3 Supply Facilities for Case-3

(1) Villa Elisa Refinery

(i) Process Units

The existing crude distillation unit will be revamped to increase its throughput capacity to 10,000 BPSD, and the operation of the existing jet fuel treating unit will be continued. In addition, a catalytic reforming unit will be introduced to produce premium gasoline. Table 11 shows the capacity of the process units.

(ii) Utility Facilities

Additional power receiving facilities with a capacity of 250 kW will be installed.

(iii) Storage Facilities

The number of new tanks is summarized in Table 12.

(iv) Wharfs

The existing two wharfs will be used, as they are.

(v) Land Shipping Facilities

The capacity of the existing facilities will be increased for gas oil and LPG, whereas the facilities for the other products will be used, as they stand.

(2) Zarate Oil Terminal

The terminal will be used, as it is, for the transshipment of the crude oil imported from Algeria.

(3) Hernandarias Depot

As in Case-1, some reinforcements and a new facility will be added to the existing depot.

CHAPTER 8 EVALUATION

8.1 Study Method

Evaluations are made on the three alternative future supply plans presented in Chapter 6 and 7, from both financial and economic viewpoints. The major differences among the alternative supply plans lie in the phase of primary supply of petroleum products, that is, domestic refining and products import, and there is no substantial difference in the domestic distribution.

As PETROPAR is exclusively responsible for the primary supply of petroleum products

Table 11 Capacity of Process Unit for Case-3

Process Unit	Capacity (BPSD)
1. Existing Crude Distillation Unit	Revamp to 10,000
2. Naphtha Hydrotreating Unit	1,600
3. Catalytic Reforming Unit	1,600

Source: JICA Mission

Table 12 Tank List for Case-3

Crude/Product	Existing Tanks		Total Requirement (Kℓ)	Additional Requirement (Kℓ)	New Tanks	
	Item No. (D9-)	Capacity (Kℓ)			Capacity (Kℓ)	Type
1. Crude Tank	901, 902, 917	62,900	111,800	48,900	50,000 x1	FR
2. Product Tank						
(1) LPG	916, 919, 920, 924, 925	300	7,000	6,700	2,000 x3 1,000 x1	SPH SPH
(2) Regular Gasoline	907, 921, 922	11,300	17,500	6,200	6,500 x1	FR
(3) Premium Gasoline	904, 905, 908, 915	6,065	7,500	1,435	1,500 x1	FR
(4) Aviation Gasoline	903, 918	1,380	1,200	–	–	
(5) Kerosene	909, 913	3,050	2,600	–	–	
(6) Jet Fuel	906, 910	2,780	9,600	6,820	7,000 x1	CR
(7) Gas Oil	923, 926, 927, 928, 929, ES-2	75,800	80,200	4,400	5,000 x1	CR
(8) Fuel Oil	911, 912, ES-1	15,760	7,100	–	–	
(9) Asphalt	935, 936, 937	1,230	3,400	2,170	2,000 x1	CRH
(10) Alcohol	914	1,680	800	–	–	
3. Intermediate Tank						
(1) SR Light Naphtha	–	–	600	600	1,000 x1	FR
(2) SR Heavy Naphtha	–	–	2,100	2,100	2,000 x1	FR
(3) Reformate	–	–	1,400	1,400	1,500 x1	FR

Source: JICA Mission

Note SPH: Spherical Tank
CR: Cone Roof Tank
CRH: Cone Roof Tank with heating
FR: Floating Roof Tank

in Paraguay, the following analysis of capital requirements, running costs, and revenues will be done in line with the current business activity of PETROPAR.

8.2 Study Basis

(1) Total Capital Requirements

The total capital requirements for each case of the future supply plans are given below, in terms of guaranis. Fixed capital includes plant construction costs, licensor's costs, initial costs of catalysts and chemicals, pre-operation expenses and interest during construction period. Working capital consists of inventories of crude oil and products, spare parts, and catalysts and chemicals.

(Unit: 10^6 Gs)

	Case-1	Case-2	Case-3
1. Fixed Capital	15,283	95,033	31,436
2. Working Capital	12,250	15,660	14,180
Total	27,533	110,693	45,616

(2) Running Cost

The following cost items which constitute the running cost are calculated on the basis of actual records of PETROPAR in 1987 and early 1988.

(a) Crude Oil Cost

For Case-2 and Case-3 where imported crude oil is refined, the crude oil cost for each year of the study period is calculated by multiplying the annual crude oil throughput by unit CIF price of the crude oil at the Villa Elisa Refinery. The CIF price of the Bonny Light and Saharan Blend crudes, which are assumed to be used in Case-2 and Case-3, respectively, are set on the basis of the government selling price of respective crudes.

(b) Petroleum Products Import Cost

Petroleum products import cost for each year is calculated as a total sum of the import value of each product imported in the year. The import value of each product is calculated by multiplying the unit CIF price of the product imported from either YPF or PETROBRAS by annual import volume from either of the two suppliers determined by each supply plan described in Chapter 6.

(c) Alcohol Cost

The cost of alcohol, which is to be mixed in the regular gasoline, is calculated on the basis of actual unit purchasing price from APAL and possible amount mixed in the regular gasoline.

(d) Utilities Cost

Costs for electricity, fuel, catalysts and chemicals are regarded as constituting the utilities cost. However, no fuel cost is included in Case-2 and Case-3, because the fuel oil is to be self-supplied in these two cases. And no catalysts and chemicals cost is included in Case-1, where all petroleum products required are to be imported.

(e) Operating Labor Cost

Operating labor cost is calculated on the basis of the number of employees required in each case. For this calculation a labor cost of 445,000 Gs/man-month is adopted as a unit cost.

(f) Administrative Cost

Administrative cost is assumed, on the basis of the actual record in 1987, to be Gs 1,000 million per year, to which 1.7% of PETROPAR's annual sales revenues is added as stamp tax.

(g) Insurance Cost and Maintenance Cost

Annual insurance cost and maintenance cost for newly installed facilities are assumed to be 1% and 3%, respectively, of the plant construction costs. For existing facilities, actual records of these two costs in 1987 are adopted.

(h) Local Transportation Cost

Local transportation cost is the cost for transporting petroleum products from the Villa Elisa Refinery to the Hernandarias Depot, and is calculated on the basis of the future supply balance of each supply plan.

(3) Depreciation Cost

Depreciation cost for the new facilities are calculated by the straight line method at 6% annually of the fixed capital. For existing facilities, depreciation cost is set on the basis of actual records in 1987.

(4) Sales Revenues

PETROPAR's shipping prices for petroleum products in 1987 are used to calculate the sales revenue.

(5) Fund Arrangement Plan

All funds required during the study period are assumed to be covered by loan in all three cases. Accordingly, foreign and local currencies to meet the expenditures for the fixed capital are to be covered by long-term loans under the conditions below.

Foreign Currency

Interest rate:	9% annually
Principal repayment:	8 annual fixed installments after the start of commercial operation

Local Currency

Interest rate:	17% annually
Principal repayment:	8 annual fixed installments after the start of commercial operation.

And, funds required in case of a cash shortfall are to be covered by short-term loan under the conditions below.

Interest rate:	8.25% annually
Principal repayment:	when funds are in excess.

(6) Tax

Transfer to the national treasury and the income tax are regarded as tax, and the total tax rate is assumed to be 51% of the profit.

(7) Study Period

It is assumed that the new facilities for all three cases of supply plan are put into commercial operation in January, 1992. And the study period is set forth as nine (9) years from January 1992 to the end of the year 2000.

8.3 Financial Evaluation

(1) Average Supply Cost

The financial cost of the primary supply of petroleum products in each case of the

supply plans is compared in terms of the average supply cost (ASC), which is defined by the following formula.

$$\sum_{i=0}^{n} \frac{ASC \times Q_i}{(1+r)^i} = \sum_{i=0}^{n} \frac{I_i + RC_i}{(1+r)^i}$$

therefore

$$ASC = \sum_{i=0}^{n} \frac{I_i + RC_i}{(1+r)^i} \Big/ \sum_{i=0}^{n} \frac{Q_i}{(1+r)^i}$$

where

ASC : Average Supply Cost

Qi : Sales volume of petroleum products in i-th year

Ii : Investment in i-th year

RCi : Running cost in i-th year (excluding depreciation cost and interest paid)

n : Study period in terms of year

As defined in the formula, ASC is an indicator which shows the supply cost averaged over the study period by use of a discount rate, and is expressed as the cost per unit quantity of petroleum products.

ASC values in the three alternative cases with a discount rate of 15% applied, are shown as base cases in Table 13. Also shown are the results of a sensitivity analysis in which the effects of changes in various factors on ASC value is examined.

Among the three alternative cases, Case-1 gives the lowest ASC value of 105 Gs/ℓ. The next lowest is 119 Gs/ℓ of Case-3, and the ASC value of Case-2 is the highest, 151 Gs/ℓ, when 15% of discount rate is applied. These results indicate that the higher the dependence on products import (dependence on domestic refining is lower), the lower the ASC value. This is caused by the fact that import price of crude oil is higher than that of almost all kinds of imported products.

As shown in Table 13, a higher discount rate gives a higher ASC value. In particular, in Case-2, which is more sensitive to the change in the discount rate than two other cases, a change of discount rate by 1% cause a change in ASC at a rate of more than 1 Gs/ℓ. The effects of change in the plant construction cost are also most noticeable in Case-2. If the plant construction cost declines by 30%, the ASC value in Case-2 decreases by 6 Gs/ℓ. ASC values in Case-2 and Case-3 are sensitive, while ASC value in Case-1 is neutral, if import price of crude oil changes. The effect is particularly remarkable in Case-2 in which a 20% decrease in the crude oil price results in a decline of ASC value by more than 20 Gs/ℓ from that of the base case. The 20% decrease in the crude oil results in a 9 Gs/ℓ

Table 13 The Results of ASC (Financial)

(Unit: Gs./ℓ)

Case		Case-1	Case-2	Case-3
Base Case (Discount Rate = 15%)		105	151	119
Sensitivity Analysis				
– Discount Rate	10%	104	144	117
	20%	107	158	122
– Plant Construction Cost	30% Down	104	145	117
	30% Up	106	156	121
– Import Price of Crude Oil	20% Down	105	130	110
	20% Up	105	172	128
– Import Price of Crude Oil and Petroleum Products	20% Down	87	128	99
	20% Up	124	173	140

Source: JICA Mission

decline in the ASC value in Case-3.

It is supposed from the above analysis that the crude oil prices in Case-2 and Case-3 need to be decreased by more than 40% and about 30%, respectively, in order for these two cases to supply petroleum products at about the same ASC value as Case-1.

Financial internal rate of return (FIRR) is calculated to examine the profitability of each of the three alternative cases, on the basis of sales prices of petroleum products by PETROPAR in 1987. These results are shown in Table 14.

Of the three alternative cases, FIRR value in Case-3, 18%, is close to 15% which is generally regarded as an acceptable FIRR value for projects related to petroleum refining. This could be interpreted to mean as follows: The supply system of petroleum products in Case-3 is similar to the current supply system, and the import costs and sales price of petroleum products used in the calculation of FIRR in this case are set approximately at the current level. On the other hand, FIRR values for Case-1 (42%) and Case-2 (minus 7%) reflect the fact that cost/price structures used in the calculation of FIRR for the respective cases are quite different from the current cost/price system.

The result of the sensitivity analysis of FIRR value to changes in the sales price of petroleum products is given in Fig. 7. If an FIRR value of around 18% is to be attained, the product sales price in Case-1 would be reduced by around 15% from the base case, whereas the product sales price in Case-2 should be raised by about 30%.

Table 14 The Results of FIRR

(Unit: %)

Item	Case-1	Case-2	Case-3
FIRR	42	-7	18

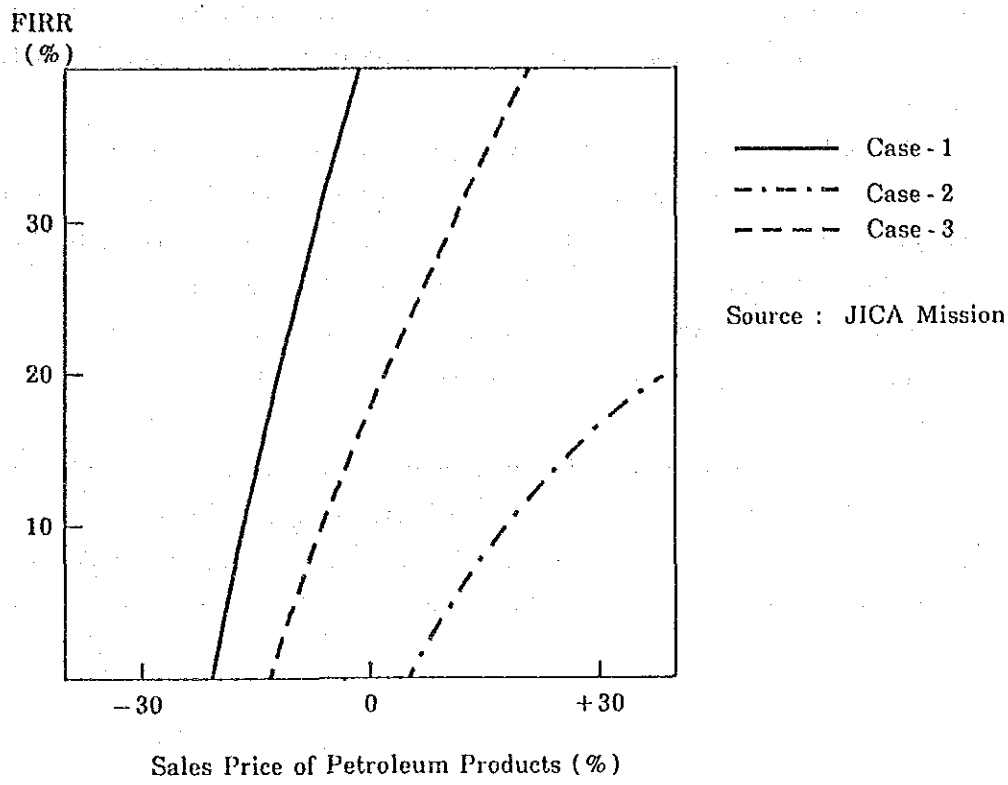


Fig. 7 FIRR vs Sales Price of Petroleum Products

8.4 Economic Evaluation

In the economic evaluation, the following adjustments are applied to the cost component defined in the financial evaluation.

(1) Application of a shadow exchange rate, which is set at Gs 550 per US dollar, to convert cost generated in US dollars into guaranis.

(2) Exclusion of taxes paid from costs, since taxes are regarded as transfer payment in the national economy.

The average economic supply cost of petroleum products for each case of supply plan are calculated by applying these adjustments, on a discount rate of 15%. These results are 109 Gs/ℓ in Case-1, 117 Gs/ℓ in Case-3 and 141 Gs/ℓ in Case-2, in the same order as of the financial evaluation.

The sensitivity to change in crude oil price of average economic supply cost is shown in Fig. 8. The economic supply cost is more substantially affected by changes in crude oil prices than in the the financial evaluation. If crude oil price should decline by about 20%, Case-3 suggests the possibility of supplying products at nearly the same economic supply cost as that of Case-1.

A sensitivity analysis is carried out to examine the effects of change in the sales price of petroleum products on profitability using the Economic Internal Rate of Return (EIRR) as an indicator. The result is shown in Fig. 9, which implies that if the acceptable EIRR from the national economic point of view should be more than 15%, this EIRR value might be expected in Case-1 and Case-3, even if sales prices of petroleum products fall from the base case. However, in Case-2, sales price may have to be raised by more than 10% in order to achieve a 15% of EIRR.

The required amount of foreign currency in each case during the study period is shown in Table 15. Case-1 requires the least amount of foreign currency among the three cases - about US$1.5 billion at the 1987 price. The medium case is Case-3 which transaction involve about US$1.6 billion. In Case-2, US$1.8 billion is necessary, the largest total of the three.

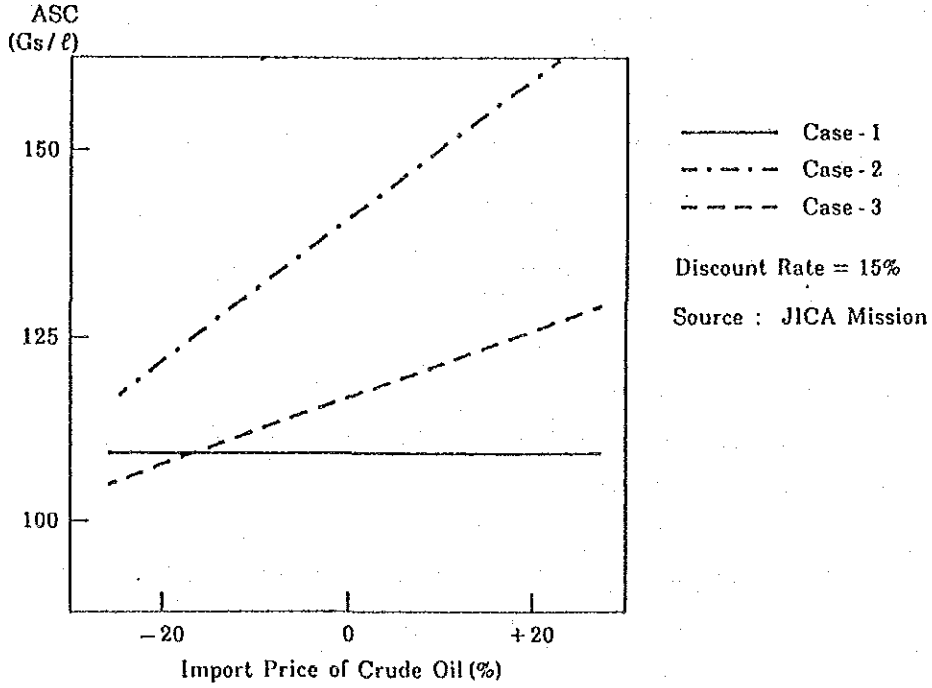


Fig. 8 A S C vs Import Price of Crude Oil (Economic)

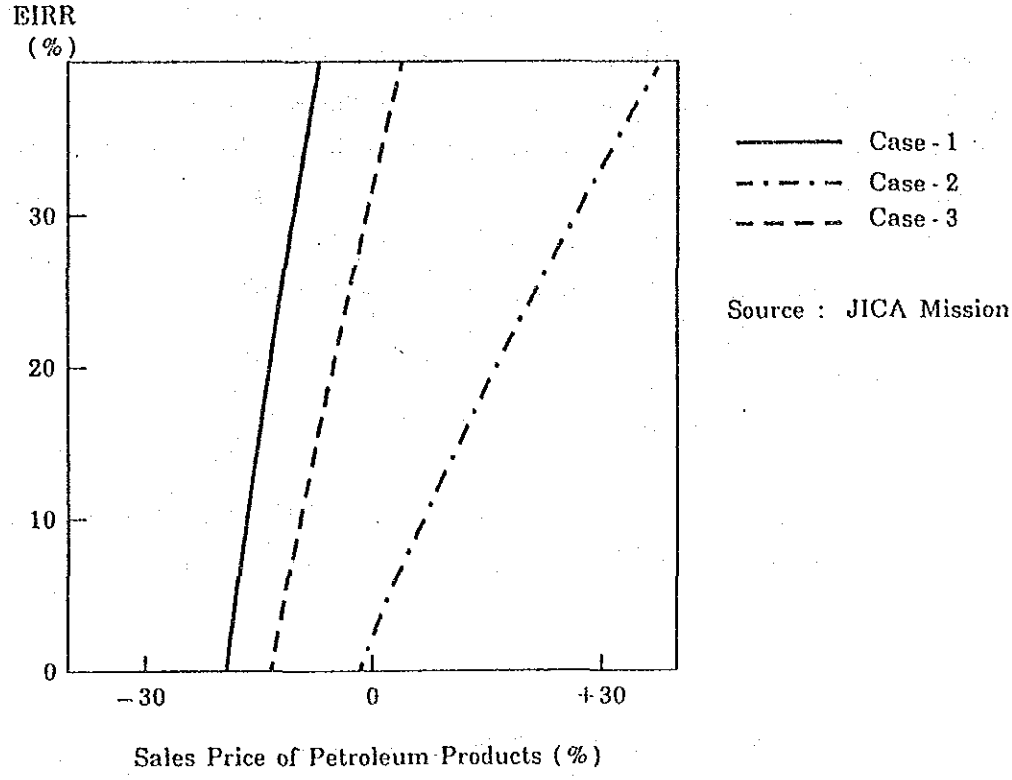


Fig. 9 EIRR vs Sales Price of Petroleum Products

Table 15 Foreign Currency Requirement

(Unit: MM US$)

	Case-1			Case-2			Case-3		
	Imp. of oil & Products	Other 1)	Total	Imp. of oil & products	Other 1)	Total	Imp. of oil & products	Other 1)	Total
1992	140	9	149	153	33	186	146	14	160
1993	144	8	152	158	31	189	150	13	163
1994	149	8	157	163	29	192	155	12	167
1995	153	8	161	169	28	197	160	12	172
1996	159	7	166	175	26	201	166	11	177
1997	165	6	171	181	24	205	172	10	182
1998	171	6	177	188	22	210	178	9	187
1999	177	5	182	195	21	216	184	9	193
2000	183	0	183	201	0	201	191	0	191
Total	1,441	57	1,498	1,583	214	1,797	1,502	90	1,592

Source: JICA Mission

1) Including refund and interest payment.

The required foreign currency for importing plant equipment in each case is balanced at closing because as soon as it flows in as a foreign loan, it flows out as payment for the plant equipment. However, item "Other" in Table 15 includes repayments of the principal and interest on foreign loans used for purchasing plant equipment. The differences in the required amount of foreign currency among the three cases almost originate in the differences in these investment funds used for purchasing new plant equipment.

Employment outside the headquarters in each case is as follows:

Case-1 244 persons

Case-2 393 persons

Case-3 324 persons

When compared with the present employment of PETROPAR, 224 persons, employment will be increased in each case: 20 persons in Case-1, about 170 persons in Case-2, and 100 persons in Case-3.

CHAPTER 9 DISCUSSION AND RECOMMENDATION

9.1 Target of Petroleum Policy

The fundamental target of the petroleum policy in an oil consuming country is a stable supply of petroleum products, i.e., to provide the consumers in the country with sufficient petroleum products as required at the lowest possible cost, averting fluctuations in cost and other market conditions. As means of stable supply of petroleum products, diversification of supply sources and expansion of oil in store are generally adopted.

The energy economy of Paraguay has a peculiar characteristic in that about three fourths of all energy consumed in the country is supplied by such non-commercial energy as firewood and vegetable residues. However, even in such a situation, petroleum is the one energy source that is indispensable for the day-to-day lives of the people as the fuel for transportation vehicles including agricultural machinery. Further, there are no other alternative energy sources for such uses.

9.2 Present Status of, and Problems with, the Petroleum Supply in Paraguay

The state-owned company of Paraguay, PETROPAR, who holds an exclusive position in the primary supply of petroleum products, has achieved the aim of stabilizing the supply of petroleum products and the domestic petroleum products market, and has made certain contributions to the government revenue.

PETROPAR, at its Villa Elisa Refinery refines imported crude oil to satisfy a part of the domestic demand for refined petroleum products, and imports refined products to fill the gap between the domestic demand and supplies from the refinery, resulting in the diversification of supply sources of petroleum products.

A calculation based on actual records in 1987 indicates, however, the average production cost of all products produced at the Villa Elisa Refinery was higher than the average import cost of imported petroleum products by about 10 guaranis per liter, or around 10%.

The value for a country to have her own domestic refinery cannot be judged by the costs of the refined products. The refinery of PETROPAR has been making contributions, both explicitly and implicitly, to the stable supply of petroleum products, and to the company's bargaining power in the import of petroleum products. The cost difference between the imported products and domestically refined products should be regarded as the price to be paid for such benefits.

In addition, the Villa Elisa Refinery is a forerunner of large-scale process industries of the country, and its employees are resourceful and high in morale, achieving a certain degree of technological competence. This value of the refinery as an industrial and technological asset of the country can never be overlooked.

The reasons for the high cost of domestically refined petroleum products are two-fold: The refinery uses the Saharan Blend crude oil, which is rather expensive in the international oil market. And the cost of transportation of the crude oil to the refinery is also high.

However, in order to cope with the structure of Paraguay's petroleum products market where the demand for heavy fuel oil is extremely small, super-light (and therefore expensive) Saharan Blend seems to be the only possible choice. And the high cost of transportation of the crude oil is caused by the fact that, since Paraguay is an inland country, there is no way to transporting crude oil but the river transportation by barge, which incurs such inevitable costs as transshipment at the mouth of the La Plata River, and loading-unloading at the Zarate Oil Terminal, due to the limitation in the water depth of the river. In consideration of the situation mentioned above, it seems that immediate cost reductions will be difficult.

Despite the high cost of the crude oil used, however, the retail prices of petroleum products to the end consumers in Paraguay are set at a level which is not very high compared to the international level and those in the neighboring countries. Therefore, there could be good reason for the acceptance of rather high costs for domestically refined petroleum products compared with that of imported products.

Paraguay at present imports petroleum products from YPF of Argentina and PETROBRAS of Brazil, national oil companies of respective big powers of South America bordering Paraguay, thereby achieving diversification of supply sources. There seems to be no

difficulties for the two countries in supplying petroleum products to Paraguay in terms of quantity.

PETROPAR has both companies submit offered prices every month, and determines the kinds and quantities of petroleum products to be purchased from each of the suppliers, thus, seemingly, paying considerations to lower-cost purchases. Even if the price offered for a certain product by one supplier is cheaper than that of the other, PETROPAR is said to have never purchased all of such petroleum product from that supplier. This is understandable as a measure to secure a stable supply of petroleum products over the long-term despite the lower cost of making a single purchase.

Transportation cost makes up a substantial portion of the cost of the imported petroleum products as well, therefore, rationalization is desired in this respect also. However, import prices from Brazil are based on CIF at the receiving terminal in Paraguay, so that there seems to be no room for PETROPAR to reduce costs. Import prices from Argentina, on the other hand, are based on FOB at the port from which the products are shipped. And the products are transported by river barge in the same way as crude oil is. Accordingly, similar problems as in the transportation of crude oil are assumed to exist.

Distribution of petroleum products, both refined at the refinery and imported, following shipment from the Villa Elisa Refinery or the Hernandarias Depot are handled by such distributors as Shell, Esso, COPETROL, etc. The maximum retail prices of petroleum products are set by a government decree. And PETROPAR decides sales margins of distributors and retailers as well as ex-PETROPAR prices of petroleum products. Under such a retail price system, it seems, there is very little motivation, if any at all, to reduce the distribution costs on the part of distributors and retailers. It is hoped that the pricing mechanism for petroleum products in Paraguay will shift to one in which the forces of the market work more effectively as the petroleum products market matures in the country.

9.3 Discussion on the Plans for the Future Supply System

In this study, three alternative cases are presented with regard to the future supply system for petroleum products in Paraguay up to the year 2000. Case-1 is an extreme in which all petroleum products required in Paraguay in the future will be supplied by imports of refined products; Case-2 is in the opposite extreme in which the future demand for petroleum products will be satisfied as far as possible by products from the domestic refinery and imports of refined products minimized; and Case-3 is in between Case-1 and Case-2.

Average Supply Cost (ASC) throughout the study period is calculated for each of these cases. When a discount rate of 15% is applied, Case-1 has the lowest ASC value of 105 guaranis, and the ASC value of Case-2 is the highest at 151 guaranis, while that of Case-3 is intermediate

at 119 guaranis.

This result is expected in view of the fact that in 1987 the actual costs of imported petroleum products were lower than those of the domestically refined products. The differences in ASC values between the three alternative cases reflects the high cost of crude oil and the differences in the amount of capital investment required for these alternative cases to increase the supply of domestically refined products.

Of these three cases, Case-2 seems to be difficult to justify because its supply cost is too high and it will make a substantial raise in petroleum product prices inevitable. Consequently, the most realistic choice would be either Case-1 or Case-3.

If "Minimum Cost" is considered as the only criterion with no room for compromise, Case-1 is the only choice possible. On the other hand, Case-3 may be acceptable if the logic employed in the cost comparison between imported products and domestically refined products in 1987 could be applied, i.e., the cost difference between the imported products and the domestically refined products is to be regarded as the price paid for the stable supply of petroleum products, for the enhancement of bargaining power concerning petroleum product imports, and for the industrial and technological asset which the country's own refinery affords. Further, examination of the financial internal rate of return (FIRR) suggests that Case-3 may be regarded as a natural extention of current supply system into the future since the cost/price relationship in this case is similar to the present one. And it could be added that Case-3 would enable Paraguay to achieve self-sufficiency in premium gasoline which is not produced at present.

Irrespective of the choice of the cases, an important problem for Parauay regarding the future supply of petroleum products is the reduction of import cost of crude oil and/or refined products, particularly their transportation cost.

Whereas the cost reduction is not easy to realise immediately, as already discussed, there could be some ways to reduce both the FOB price and the transportation cost of the crude oil and refined products imported. Therefore, it is desired that PETROPAR and the Government of Paraguay intensify their effort to this direction.

In this respect, it should be added that pipelines described in Appendix 7 of this report are worth further detailed study as alternative means of petroleum transportation. .